I CLAIM:

1. In the method of detecting a sun gear fault, in the operation of an epicyclic gear train having ring, planet and sun gears, and a planet carrier, the steps that include

a) detecting sun gear vibrations transmitted through each planet gear,

b) computing separated averages of such detected vibrations,

c) phase shifting said averages to account for the differences in gear meshing positions,

d) and re-combining said phase shifted averages to produce a modified average value of the sun gear vibration.

2. The method of claim 1 wherein a detection transducer is provided and operated on the ring gear.

3. The method of claim 1 wherein one separated average is selected as a reference, and the remaining averages are phase shifted by the angle between its planet and the reference planet so that the beginning of each separated average starts with the same sun gear tooth in mesh with each planet, and all the separated averages are aligned.

4. The method of claim 3 wherein a detection transducer is provided and operated on the ring gear.

5. The method of claim 2 wherein the sun gear vibration is transmitted to the transducer through the individual planet gears, and the expected sun gear vibration signal detected by the transducer is the sum of the sun gear vibration with each planet multiplied by the individual planet pass modulations.

6. The method of claim 5 wherein the expected sun gear vibration signal $X_s(t)$ is determined substantially in accordance with the following equation (6) represented as follows:

$$x_s(t)=\sum_{p=0}^{P-1}\alpha_p(t)\nu_{s,p}(t),$$

where: $\alpha_p(t)$ is the amplitude modulation due to planet p, and $\nu_{s,p}(t)$ is the tooth meshing vibration of the sun gear with planet ρ.

7. The method of claim 5 wherein the expected sun gear vibration signal $x_s(\theta)$ expressed in the angular domain is determined substantially in accordance with the following equation (7) represented as follows:

$$x_s(\vartheta)=\sum_{p=0}^{P-1}\alpha_p\left(\frac{N_s}{N_r}\theta\right)\nu_{s,p}(\vartheta),$$

where θ is the relative rotation of the sun with respect to the planet carrier.

8. The method of claim 4 wherein the amplitude modulation function (8) (planet-pass modulation), $\alpha_p(\varphi)$, has the same form for all planets, differing only by a phase delay, $2\pi p/P$,

$$\alpha_p(\varphi)=\alpha\left(\varphi-\frac{2\pi p}{P}\right),$$

where $\alpha(\varphi)$ is the planet-pass modulation function and

φ is the planet carrier angle

p is planet p

P is the number of planets

9. The method of claim 1 wherein steps a) and b) include providing and operating a filter proportionally dividing the overall vibration signal into estimated contributions from each planet gear.

10. The method of claim 9 wherein separated sun gear values $\bar{z}_{s,p}(\theta)$ are derived.

11. The method of claim 10 wherein said value $\bar{z}_{s,p}(\theta)$ taken over N periods of the relative sun gear rotation is represented substantially by the following equation (10):

$$\begin{aligned}\bar{z}_{s,p}(\theta) &= \frac{1}{N}\sum_{n=0}^{N-1} w\left(\frac{N_s}{N_r}(\theta+2\pi n)-\frac{2\pi p}{P}\right)x_s(\theta+2\pi n)\\ &= \frac{1}{N}\sum_{n=0}^{N-1} w\left(\frac{N_s}{N_r}(\theta+2\pi n)-\frac{2\pi p}{P}\right)\left[\sum_{k=0}^{P-1} a\left(\frac{N_s}{N_r}(\theta+2\pi n)-\frac{2\pi k}{P}\right)v_{s,k}(\theta+2\pi n)\right]\\ &= \sum_{k=0}^{P-1}\bar{v}_{s,k}(\theta)\frac{1}{N}\sum_{n=0}^{N-1} w\left(\frac{N_s}{N_r}(\theta+2\pi n)-\frac{2\pi p}{P}\right)a\left(\frac{N_s}{N_r}(\theta+2\pi n)-\frac{2\pi k}{P}\right),\end{aligned}$$

where $\bar{v}_{s,k}(\theta)$ is the mean vibration of the sun gear with planet k.

12. The method of claim 10 wherein a modified sun gear average value $\bar{z}_{s,m}(\theta)$ is derived and represented substantially by the following equation

$$\bar{z}_{s,m}(\theta)=\sum_{p=0}^{P-1}\sum_{k=0}^{P-1}\bar{v}_{s,k}\left(\theta-\frac{2\pi p}{P}\right)\left[W_0A_0+2\sum_{l=1}^{P-1}W_lA_l\cos\left(l(k-p)\frac{2\pi}{P}\right)\right],$$

where the delay, $2\pi p/P$, aligns the mean sun gear vibration with each planet, $\bar{v}_{s,k}(\theta)$, so that the beginning of each separated average starts with the same sun gear tooth in mesh with each planet.

13. The method of claim 10 wherein a modified sun gear average value $\bar{Z}_{s.m}(\theta)$ is derived and represented substantially by the following equation (20)

$$\bar{z}_{s,m}(\theta) = \bar{v}_s(\theta) \sum_{p=0}^{P-1} \sum_{k=0}^{P-1} \left[W_0 A_0 + 2 \sum_{l=1}^{P-1} W_l A_l \cos\left(l(k-p) \frac{2\pi}{P} \right) \right]$$

$$= P W_0 A_0 \bar{v}_s(\theta),$$

where $\bar{Z}_{s,m}(\theta)$ is the mean vibration of the sun gear with a single planet gear.